REMARKS:

Reconsideration of this application, as amended, is respectfully requested.

The claims, specification and abstract have been amended to overcome the objections thereto.

Claims 1-4 and 10 were rejected under 35 U.S.C. §103(a) as allegedly obvious over Ikegame in view of Hayakawa. Claims 5-7 and 17 were rejected as allegedly obvious over the foregoing combination further in view of Tachikawa or Makabe. Claims 8 and 9 were rejected over the combination of Ikegame in view of Hayakawa and Hirose.

Claims 11-15 were rejected as allegedly obvious over Hirose in view of either Tachikawa or Makabe, and claim 16 was rejected as allegedly obvious over Hirose in view of either Tachikawa or Makabe, further in view of Ikegame. Applicants respectfully traverse.

The present invention relates to an optical pick-up for use in an information recording/read apparatus in which the bearing surface has excellent roundness and parallelism of the lens receiving surfaces can be maintained with high accuracy (See page 40, second paragraph).

For example, squareness of the bearing surface to the lens receiving surface is within the range of 7 to 8 μm, while the squareness of the bearing surface to the lens receiving surface is 12 to 16 μm at best in the prior art as shown in Fig. 9 or 10 shown in the present application.

The excellent roundness and parallelism properties are achieved by use of resin molded product having a gate at an end of the bearing part disposed at an opposite side of the lens receiving surface. The gate is disposed parallel to an inside perimeter of the bearing part.

Turning to the cited references, Hayakawa describes a method of producing a lens holder by disposing at a center hole into which a center axis is inserted a gate for injecting a resin containing a filler having shape anisotropy, injecting the resin containing the filler from the gate, and directing the filler symmetrically to an axis center of the center axis. An object of Hayakawa is to avoid shrinkage cavity on a sliding hole of the lens holder and to improve roundness.

Hayakawa also discloses that a resin is typically injected from a side gate 110 disposed at a side of a lens fixed part in the lens holder produced by injection molding.

In sharp contrast, according to claim 1 of the present invention, it is an object to provide a lens holder having a bearing surface formed vertically to a lens receiving surface. This object cannot be achieved by Hayakawa or by the prior art described in Hayakawa.

Hayakawa describes a pin gate, a side gate or that both are used to injection-mold the lens holder. However, the lens holder according to claim 1 of the present invention does not use any of these. The lens holder according to claim 1 of the present invention is produced using a gate disposed at an end part of a bearing opposite to a lens supporting part and parallel to an inside parameter of the bearing part. In other words, the lens holder of the present invention is produced using a disc gate. There is no hint or suggestion to produce the lens holder using a disc gate in the cited references.

In the lens holder according to claim 1, a gate disposed parallel to the inside perimeter of the bearing part is used. Therefore, a cavity corresponding to the size of the gate is formed between a core pin for forming a bearing hole and a concave part of a fixed template. The cavity prevents the core pin from tilting. The lens holder according to claim 1 provides a significant advantage in that a bearing surface is formed vertically to the lens receiving surface.

Specifically, the squareness of the bearing surface to the lens receiving surface is within the range of 7 to 8 μm.

In the prior art, squareness of the bearing surface to the lens receiving surface is about 12 to 16 μm at best, even if a precise mold is produced. When the squareness of the bearing surface to the lens receiving surface is 12 to 16 μm, in the case of the lens having a plurality of lens receiving surfaces such as according to claim 3 of the present invention, parallelism of the lens receiving surfaces cannot be maintained with high precision, whereby it is very difficult to fix an objective lens.

The Examiner alleges that Ikegame discloses an optical pick-up having the following elements: (a) a resin mold comprising a lens support having a support axis and a lens receiving surface and (b) a lens holder having a bearing part which fits on the supporting shaft rotatably, (c) the bearing part having a bearing surface disposed vertically to the lens receiving surface; (d) the optical pick-up having a plurality of lens receiving surfaces (e) the resin molding product being a liquid crystal resin composition. However, Ikegame is quite different with respect to element (c) of the present invention. The bearing surface of the present invention has excellent roundness, and parallelism of lens receiving surfaces can be maintained with high accuracy. Excellent roundness and parallelism could be accomplished by using resin molded product comprising a gate at an end of the bearing part disposed at an opposite side of said lens receiving surface and the gate id disposed parallel to an inside perimeter of said bearing part.

Ikegame and Hayakawa do not disclose the importance of the squareness, for example, it is more important for the lens holder to include a plurality of object lens holes, as in Claim 16.

Claim 11 is directed to an optical pick-up having a supporting shaft, and a lens holder having a bearing part that fits on said supporting shaft rotatably. The optical pick-up is required to have much higher response performance of a serve control, especially to have dimensional accuracy of the lens holder.

It is known that there are many types of optical pick-ups for example, a wire supporting type, hinge system type, including the optical pick-up having a supporting shaft as in claim 11.

The optical pick-up having a supporting shaft comprises a pick-up base, a lens holder, a supporting shaft and a bearing. The lens holder is required to have good sliding properties with respect to the supporting shaft.

Tachikawa and Makabe disclose resin composition improved flowability and metering stability. Also, they disclose an optical-pick up in general. They do not disclose the optical-pick up having a supporting shaft of the present invention, nor the lens holder made of a molded product of a liquid crystal resin composition.

Tachikawa clearly teaches away from the use of liquid crystal resin alone as a base resin.

Although.Makabe discloses in general that the composite is available as an optical pick up, he does not disclose which parts or what types are available in the optical pick ups. As claimed in claim 11, the present invention includes an optical pick up having a supporting shaft. It is required that the lens holder of the optical pick up having a supporting shaft has a sufficient sliding property with the shaft.

Makabe does not disclose any information about sliding properties. As can be seen in Table 1 and 2 of the specification, the importance of the sliding property as indicated in evaluation test of static friction coefficient are provided and discussed.

Hirose does not disclose the importance of the sliding property of the lens holder applied to optical- pick up having the supporting shaft as shown, e.g., in Table 2. Hirose also fails to disclose a liquid crystal resin composition having flexural elastic modulus of 10 GPa or more with fewer burrs produced upon molding.

Compared to others, an optical pick up comprising ceramics of zirconia and the molded product of a liquid crystal resin composition as claimed in claim 1 yield excellent evaluation test results including the status friction coefficient as shown in Table 1 and 2. These features are obtained by the presently claimed invention.

In view of the foregoing, allowance is respectfully requested.

If any additional fees are due for entry of this amendment, authorization is given to charge deposit account no. 50-0624.

Respectfully submitted,

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Enclosures

to write and detect information.

A2 In addition, when the lens holder on which the lens receiving surface and the bearing surface are provided not vertically is used, it becomes difficult to fix the objective lens, resulting in low working efficiency and high number of ~~defective~~ DEFECTS

Especially when the lens holder includes two or more of objective lenses, there is a problem that parallelism of lens receiving surfaces cannot be maintained with high accuracy. When the pin point gates 21 in odd numbers as shown in FIG. 9 are used to form the lens holder, a weld line is produced at about center between the gates to decrease roundness of the bearing surface. Therefore, a post-processing is needed to increase accuracy of the bearing part, which leads to problems such as decreased productivity, and increased manufacturing costs. On the other hand, when the material is injected from outside of the cavity 18 using the side gate 22 shown in FIG. 10, the material is injected with different pressures depending on areas, i.e., an area distant from the gate 22, and an area near the gate, resulting in an inaccurate lens receiving surface.

Japanese Patent Publication No. 2886741 describes a

method for producing a lens holder, in which gates are provided so that a filler is oriented in an axis direction of an almost all bearing part.

According to the Japanese Patent Publication No. 2886741, it is required to use very small sprues and gate ports which provide the pin pint point gates around the bearing part with a bearing hole size of 1.0 to 2.0 mm for a light-weighted miniature lens holder currently available. When the sizes of sprues and gate ports are diminished, it becomes difficult to form the mold, and the resin material having a high elastic modulus may easily cause a short shot.

When the pin point gates are provided around the bearing part, and the resin material, especially a liquid crystal resin, is injected, the melted resin with which the bearing part is filled flows to a lens supporting part to easily induce a turbulent flow of the resin at an intersection (bridge portion) of the bearing part and the lens supporting part. As a result, mechanical strength may be decreased.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a

surface.

The lens holder for the optical pick-up is formed by injecting a resin from a gate provided on a gap between a cavity in the bearing part of a fixed template and a core pin. The resin material is distributed at a uniform pressure from a tip of the bearing part to a perimeter of the lens supporting part. As a result, a density unevenness in the bearing part can be avoided to enhance the roundness of the bearing surface in the lens holder.

NE

Other optical pick-up of the present invention comprises a supporting shaft formed of ceramics containing zirconia, and a bearing part formed of a molded product of a liquid crystal resin composition or a polyphenylene ether resin composition having flexural elastic modulus of 10 GPa or more. With the above-described combination of the supporting shaft and the lens holder including the bearing part, the supporting shaft and the bearing part can be worked with high

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precision. The deflexion and vibration of the lens holder upon driving control can be prevented. Thus, the gap between the supporting shaft and the bearing hole, i.e., the fit-on gap therebetween can be allowed to be 6 μm or less. Consequently, the objective lens can be supported

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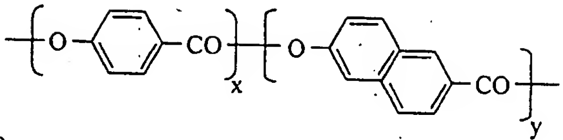

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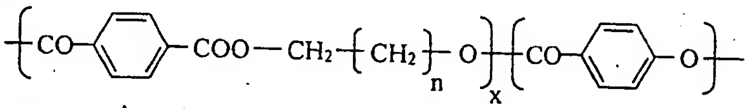


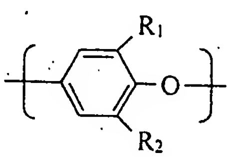
where n is 0 or 1, and each of x, y, z represents an arbitrary integer.

A1

Any liquid crystal resin may be used as long as it forms an anisotropic melting phase, i.e., thermotropic liquid crystalinity. CRYSTALLINITY

Various types of polyphenylene ether resins can be used in the present invention. Examples include a homopolymer of 2,6-disubstituted phenyl represented by the repeated unit (10), an oxidized copolymer of 2,6-disubstituted phenol and multivalent phenol, and the like, which generally have a number average molecular weight of 2000 or more, preferably 10000 to 35000.

(10)



where R_1 and R_2 represent hydrogen; halogen; alkyl, haloalkyl, or alcoxy containing 4 or less carbon atoms; or allyl derivative, or an aralkyl group containing 9 or

of 240 to 500 GPa. If values of the tensile strength and the tensile elastic modulus are below the respective lower limit, elasticity becomes poor to increase
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deflexion, resulting in lowered reading accuracy. If these values exceed the respective upper limits, moldability is decreased, and the supporting shaft that is a mate for sliding may be attacked and worn.

The PAN carbon fiber has a mean fiber diameter of preferably 1 to 20 μm, more preferably 5 to 10 μm, a fiber length of about 10 to 1000 μm, preferably 10 to 500 μm, more preferably about 10 to 300 μm, and an aspect ratio of preferably 1 to 80, more preferably 5 to 50. If the mean fiber diameter of the PAN carbon fiber is less than 1 μm, the fiber agglomerates each other, and is difficult to be uniformly dispersed in the resin composition. If the mean fiber diameter of the PAN carbon fiber exceeds 20 μm, the flowability and the injection moldability are decreased. If the aspect ratio of the PAN carbon fiber is less than 1, a reinforcing effect of a matrix itself is interfered, and the mechanical characteristic is decreased. If the aspect ratio of the PAN carbon fiber exceeds 80, uniform dispersion upon mixing is extremely difficult, which may improve

supporting shaft 2 shown in FIG. 4 and the hollow cylindrical supporting shaft 2 shown in FIG. 5, supposing that the length of each of the supporting shafts 2 is 5-20 mm and the diameter of each thereof is 1.0 to 2.0 mm, the dimensional tolerance of the outer diameter thereof can be maintained at a tolerance range within 10 μm or preferably within 4 μm.

Regarding the dimensional accuracy of the supporting shaft and the bearing part formed of molded and sintered ceramics containing zirconia, polishing allows the cylindricity of the sliding-contact surface of each thereof to have a 6 μm or less finish and/or the center line average roughness (Ra) of the sliding contact surface of each thereof to have a 3 μm or less finish. By so polishing the ceramics that the supporting shaft and the bearing part have the above configuration, it is possible to enhance the dimensional accuracy of the fit-on gap between the supporting shaft 2 and the bearing part 5a shown in FIGS. 4 and 5.

In order for the sliding contact surface of the supporting shaft and the bearing part both made of the ceramics containing zirconia to have a center line average roughness (Ra) of 3 $\overset{\mu}{\text{mm}}$ or less, it is necessary

rigidity of the cylindrical supporting shaft is higher than that of the supporting shaft having other configurations. Consequently, the cylindrical supporting shaft has a high natural frequency and thus occurrence of resonance can be prevented.

Referring to FIG. 6, a method for producing the lens holder 6 will be described.

An injection mold 10 comprises a fixed template 11 and a moving template 12. A cavity 13 is formed between the fixed template 11 and the moving template 12. The cavity 13 comprises a cavity 13a forming a lens supporting part, and a cavity 13b forming a bearing part. The fixed template 11 includes a sprue and a runner (both are not shown) through which a resin material passes. The moving plate 12 includes an ejector pin (not shown) that is for removing a molded product, and also includes a core pin 14 that penetrate into a center of the cavity 13b. A gate 15 is formed between the cavity 13b of the fixed template 11 and the core pin 14.

When the fixed template 11 and the moving template 12 are abutted to close the injection mold 10, the core pin 14 can be hold HELD in the cavity 13 with the core pin 14 in the fixed template 11 unconstrained. The resin

filler) with the injection mold shown in FIG. 7. The bearing surface of the resultant lens holder had roundness of 1 to 2 μm, and standard deviation of 0.3 μm. The bearing part had no weld line.

An orientation of the carbon fiber in an axis direction (FIG. 2) was observed with a microscope. The result is shown in FIG. 8. The carbon fiber was oriented from an end of the bearing part disposed at an opposite side of the lens receiving surface to the lens supporting part (in FIG. 8, direction B), and then to a perimeter of the lens supporting part (in FIG. 8, direction C). In other words, the carbon fiber was oriented not to the axis direction of the bearing part 5, i.e., the direction B, but to the perimeter of the lens supporting part, i.e., the direction C, in the are AREA of the lens supporting part 5b and the bridge portion 5d.

Comparative Embodiment 1

The lens holder for the optical pick-up shown in FIG. 1 was injection molded using the liquid resin composition used in Embodiment 1 with the pin gate type injection mold shown in FIG. 9. The bearing surface of the resultant lens holder had roundness of 5 to 7 μm, and